

---

# UNIVERSITI SAINS MALAYSIA

Second Semester Examination  
2014/2015 Academic Session

June 2015

## **EAH325/3 – Engineering Hydrology** **[Hidrologi Kejuruteraan]**

Duration : 3 hours  
[Masa : 3 jam]

---

Please check that this examination paper consists of **TWELVE (12)** pages of printed including including **THREE (3)** appendices before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **DUA BELAS (12)** muka surat yang bercetak termasuk **TIGA (3)** lampiran sebelum anda memulakan peperiksaan ini.]*

**Instructions** : This paper contains **SIX (6)** questions. Answer **FIVE (5)** questions.

**[Arahan** : Kertas ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan.]

All questions **MUST BE** answered on a new page.

*[Semua soalan **MESTILAH** dijawab pada muka surat baru.]*

In the event of any discrepancies, the English version shall be used.

*[Sekiranya terdapat percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.]*

1. (a) Water seldom exist in pure form. Thus, the water cycle plays an important role in the movement of water particles. With the aid of a sketch diagram, briefly explain any **THREE (3)** processes involved in water cycle.

*Air jarang wujud dalam keadaan tulennya. Oleh itu, kitaran air memainkan peranan yang penting dalam pergerakan zarah-zarah air. Dengan bantuan rajah lakaran, terangkan secara ringkas mana-mana **TIGA (3)** proses yang terlibat dalam kitaran air.*

[5 marks/markah]

- (b) A catchment has 7 raingauge stations. The normal annual rainfall depths for all the seven stations are given in **Table 1**. Determine the optimum number of raingauge stations to be established in the catchment if it is desired to limit the error in the mean value of rainfall to 10%.

*Satu kawasan tadahan mempunyai tujuh stesen alat ukur hujan. Kedalaman hujan tahunan normal untuk kesemua tujuh stesen diberi seperti dalam **Jadual 1**. Tentukan bilangan optimum alat ukur hujan yang diperlukan di kawasan tadahan terbabit sekiranya diperlukan untuk menghadkan ralat nilai purata air hujan kepada 10%.*

[5 marks/markah]

**Table 1/Jadual 1**

Stations/Stesen	A	B	C	D	E	F	G
Normal annual rainfall (cm)/Hujan tahunan normal (cm)	62	94	62	47	32	88	70

- (c) A reservoir with average surface spread of  $3.3 \text{ km}^2$  has the water surface temperature of  $22.5^\circ\text{C}$  and relative humidity of 35% in December. Wind velocity measured at 2.0 m above the ground at a nearby observatory is 15 km/h. Calculate average evaporation loss from the reservoir in mm/day and the total depth and volume of evaporation loss for December.

*Sebuah takungan dengan purata bukaan permukaan  $3.3 \text{ km}^2$  mempunyai suhu air permukaan  $22.5^\circ\text{C}$  dan kelembapan relatif sebanyak 35% pada bulan Disember. Kelajuan angin pada 2.0 m di atas paras tanah pada balai cerap yang berdekatan diukur pada kelajuan 15 km/j. Kira purata kehilangan penyejatan daripada takungan tersebut dalam mm/hari dan jumlah kedalaman serta kehilangan penyejatan untuk bulan Disember.*

[10 marks/markah]

2. (a) Briefly describe **FOUR (4)** factors that will affect evaporation process.

*Terangkan secara ringkas **EMPAT (4)** faktor yang memberi kesan kepada proses penyejatan.*

[4 marks/markah]

- (b) There are several ways of measuring lake evaporation, and some of it involve analytical methods for lake evaporation estimation. Explain the analytical methods that can be applied for lake evaporation determination.

*Terdapat beberapa cara untuk mengukur penyejatan tasik, dan sebilangannya melibatkan cara analitik dalam penentuan anggaran penyejatan. Terangkan cara-cara analitik yang boleh diaplikasikan untuk penentuan penyejatan tasik.*

[6 marks/markah]

- (c) **Table 2** shows the annual average precipitation at Station A and the average annual rainfall of 5 surrounding stations from year 1984 to 1992. Station A was permanently removed at the end of 1989. Check the consistency of data of Station A. If data is found to be inconsistent, correct the inconsistent data.

*Jadual 2* menunjukkan purata hujan tahunan di Stesen A dan purata hujan tahunan di lima stesen di sekelilingnya dari tahun 1984 ke 1992. Stesen A telah dialihkan secara tetap di penghujung 1989. Semak ketekalan data Stesen A. Sekiranya data dijumpai tidak konsisten, perbetulkan data tersebut.

[10 marks/markah]

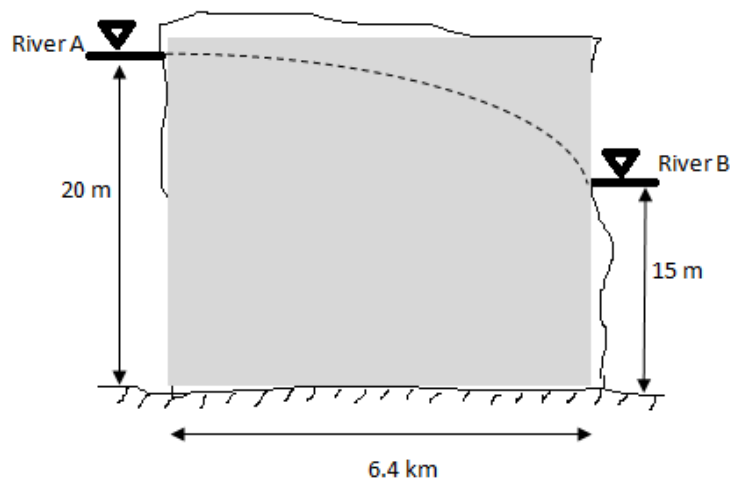
**Table 2/Jadual 2**

Year/Tahun	Annual average precipitation of Station A (mm)/Purata hujan tahunan Stesen A(mm)	Annual average precipitation of 5 surrounding Station A (mm)
1984	1120	1230
1985	1250	1350
1986	1380	1440
1987	1210	1360
1988	1760	1730
1989	1400	1080
1990	1240	970
1991	1760	1320
1992	1480	1350

3. (a) Two rivers A and B (**Figure 1**) are separated by an aquifer formation of 6.4km. Determine the K value if the seepage flow per unit length is  $0.535 \text{ m}^3/\text{day}$ .

*Dua sungai A dan B (Rajah 1) dipisahkan oleh pembentukan akuifer selebar 6.4km. Tentukan nilai K jika aliran resapan per unit panjang adalah  $0.535 \text{ m}^3/\text{hari}$ .*

[7 marks/markah]



**Figure 1/Rajah 1**

- (b) A fully penetrating well with an outside diameter of 0.5 m discharges a constant  $0.08 \text{ m}^3/\text{s}$  from a confined aquifer whose coefficient of transmissibility is  $25 \times 10^{-3} \text{ m}^2/\text{s}$ . The drawdown value for this case is 4 km away. Estimate the drawdown at the well face.

*Telaga tembus sepenuhnya berdiameter luar 0.5 m mengeluarkan kadar alir tetap  $0.08 \text{ m}^3/\text{s}$  dari akuifer terkurung yang pekali kebolehpindahan adalah  $25 \times 10^{-3} \text{ m}^2/\text{s}$ . Nilai susutan aras untuk kes ini adalah 4 km terpisah. Anggarkan susutan aras di muka telaga.*

[7 marks/markah]

- (c) Discharge measurement at river section can be carried out by few methods. With the aid of a sketch diagram, explain **THREE (3)** methods of discharge measurement.

*Pengukuran kadar alir di seksyen sungai boleh dilakukan dengan beberapa kaedah. Dengan bantuan lakaran gambarajah, terangkan **TIGA (3)** kaedah pengukuran kadar alir.*

[6 marks/markah]

...6/-

4. (a) The rating curve of a current meter used for measuring velocity in a small river is given as  $V = 0.62N + 0.032$  m/s, where  $N$  is the revolutions/s. Calculate the discharge of the river from the following data (**TABLE 3**). Velocity is measured at the mid of the sections.

*Lengkung kadaran sebuah meter semasa digunakan untuk mengukur halaju di sebuah sungai kecil diberikan sebagai  $V = 0.62N + 0.032$  m/s, dimana  $N$  adalah revolusi/s. Kira kadar alir sungai daripada data berikut (**Jadual 3**). Halaju dikira di bahagian pertengahan seksyen.*

**Table 3/Jadual 3**

Distance from bank (m)	0	2	5	8	12	15	18	21	23	24
Depth (m)	0	0.6	1.2	1.8	2.4	1.9	1.4	1.1	0.5	0
N at 0.6d	0	60	90	120	150	140	100	80	50	0
Time (s)	0	150	140	140	160	140	140	140	140	0

[14 marks/markah]

- (b) With the aid of sketch diagram, define the following terms:

*Dengan bantuan lakaran gambarajah, berikan definisi terminologi berikut:*

- i) Effluent streams  
*aliran efluen*
- ii) Influent streams  
*aliran influen*
- iii) Perched water table  
*aras air tenggek*

[6 marks/markah]

- 5, The occurrence of twelve hour of continuous rainfall in Kampung Pisang has resulted into widespread flooding. The effective rainfall at 4 hour interval for twelve hour is given in **Table 4**. The formulation of effective plan for flood mitigation requires an estimation of direct runoff volume generated from the effective rainfall event given in **Table 4**. The 2 hr-UH for the area provided by the consultant firm is given in **Table 5**. Estimate the volume of direct runoff using the information given in **Table 4** and **Table 5**.

*Kejadian hujan berterusan selama dua belas jam telah menyebabkan banjir di Kampung Pisang. Hujan efektif dengan sela masa 4 jam untuk dua belas jam diberikan di dalam **Jadual 4**. Perangkaan penyelesaian untuk tebatan banjir yang efektif memerlukan kepada maklumat isipadu air larian terus yang dijanakan oleh kejadian hujan yang diberikan di dalam **Jadual 4**. Syarikat Perunding telah menyediakan 2-jam UH untuk kawasan tersebut dan diberikan di dalam **Jadual 5**. Anggarkan isipada air larian terus menggunakan maklumat yang diberikan di dalam **Jadual 4** dan **Jadual 5**.*

[20 marks/markah]

**Table 4 - Effective Rainfall**  
**Jadual 4 - Hujan Efektif**

Time (hour) Masa (jam)	Effective Rainfall (mm) Hujan Efektif (mm)
0 - 4	90
4 - 8	140
8 - 12	80

**Table 5 - 2 hours UH**  
**Jadual 5 - 2 jam UH**

Ordinate (1 hour) <i>Ordinat (1 jam)</i>	2-hour UH (m <sup>3</sup> /s/cm)
0	0
2	30
4	90
6	128
8	170
10	150
12	122
14	64
16	40
18	26
20	0

6. Jabatan Kerja Raya plans to construct a bridge across the river in Northern Seberang Perai, Penang. The design of the bridge requires some analysis on the flood probability and magnitude. The record of average annual discharge for a streamflow gauging station is given in **Table 6**. Assuming the data is normally distributed, determine the following:

*Jabatan Kerja Raya merancang untuk membina jambatan merentangi sebuah sungai di Seberang Perai Utara, Pulau Pinang. Rekabentuk jambatan tersebut memerlukan analisis kebarangkalian dan magnitud banjir. Rekod purata kadalir tahunan untuk stesen pengukuran kadalir sungai diberikan dalam **Jadual 6**. Dengan anggapan data menunjukkan taburan normal, tentukan perkara berikut:*

- (i) the probability of average annual streamflow discharge  $\geq 150 \text{ m}^3/\text{s}$   
*kebarangkalian purata tahunan kadalir  $\geq 150 \text{ m}^3/\text{s}$*
- (ii) the probability of average annual streamflow discharge  $\leq 75 \text{ m}^3/\text{s}$   
*kebarangkalian purata tahunan kadalir  $\leq 75 \text{ m}^3/\text{s}$*



- (iii) the magnitude of average annual streamflow discharge with 100 year return period.

*Magnitud purata tahunan kadaralir dengan 100 tahun kala ulangan.*

[20 marks/markah]

**Table 6/Jadual 6**

Year/Tahun	Average Discharge/ Purata Kadaralir ( $m^3/s$ )	Year/Tahun	Average Discharge/Purata Kadaralir ( $m^3/s$ )
2014	100.0	2006	120.0
2013	89.0	2005	95.0
2012	130.0	2004	140.0
2011	125.0	2003	115.0
2010	90.0	2002	85.0
2009	92.0	2001	40.0
2008	67.0	2000	55.0
2007	73.0	1999	85.0

**APPENDIX 1/LAMPIRAN 1**

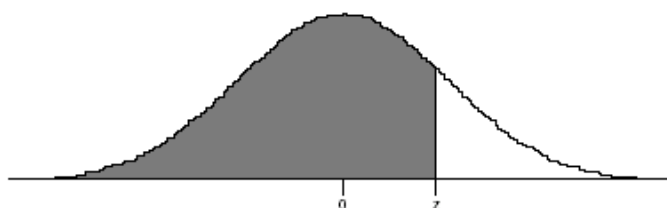
$$C_v = \frac{100 \times \sigma_{m-1}}{\bar{P}}$$

$$N = \left( \frac{C_v}{\varepsilon} \right)^2$$

$$E_L = K_M (e_w - e_a) \left( 1 + \frac{u_9}{16} \right)$$

## APPENDIX 2/LAMPIRAN 2

## NORMAL DISTRIBUTION TABLE



Normal Deviate z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
-4.0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3.9	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3.8	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3.7	.0001	.0001	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
-3.6	.0002	.0002	.0001	.0001	.0001	.0001	.0001	.0001	.0001	.0001
-3.5	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002	.0002
-3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
-3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
-3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
-3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
-3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
-2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
-2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
-2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
-2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
-2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
-2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
-2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
-2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
-2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
-2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
-1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
-1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
-1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
-1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
-1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
-1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
-1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
-1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
-1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
-1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
- .9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
- .8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
- .7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
- .6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
- .5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
- .4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
- .3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483

- 12 -

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.0000	0.0040	0.0080	0.0120	0.0160	0.0199	0.0239	0.0279	0.0319	0.0359
0.1	0.0398	0.0438	0.0478	0.0517	0.0557	0.0596	0.0636	0.0675	0.0714	0.0753
0.2	0.0793	0.0832	0.0871	0.0910	0.0948	0.0987	0.1026	0.1064	0.1103	0.1141
0.3	0.1179	0.1217	0.1255	0.1293	0.1331	0.1368	0.1406	0.1443	0.1480	0.1517
0.4	0.1554	0.1591	0.1628	0.1664	0.1700	0.1736	0.1772	0.1808	0.1844	0.1879
0.5	0.1915	0.1950	0.1985	0.2019	0.2054	0.2088	0.2123	0.2157	0.2190	0.2224
0.6	0.2257	0.2291	0.2324	0.2357	0.2389	0.2422	0.2454	0.2486	0.2517	0.2549
0.7	0.2580	0.2611	0.2642	0.2673	0.2704	0.2734	0.2764	0.2794	0.2823	0.2852
0.8	0.2881	0.2910	0.2939	0.2967	0.2995	0.3023	0.3051	0.3078	0.3106	0.3133
0.9	0.3159	0.3186	0.3212	0.3238	0.3264	0.3289	0.3315	0.3340	0.3365	0.3389
1.0	0.3413	0.3438	0.3461	0.3485	0.3508	0.3531	0.3554	0.3577	0.3599	0.3621
1.1	0.3643	0.3665	0.3686	0.3708	0.3729	0.3749	0.3770	0.3790	0.3810	0.3830
1.2	0.3849	0.3869	0.3888	0.3907	0.3925	0.3944	0.3962	0.3980	0.3997	0.4015
1.3	0.4032	0.4049	0.4066	0.4082	0.4099	0.4115	0.4131	0.4147	0.4162	0.4177
1.4	0.4192	0.4207	0.4222	0.4236	0.4251	0.4265	0.4279	0.4292	0.4306	0.4319
1.5	0.4332	0.4345	0.4357	0.4370	0.4382	0.4394	0.4406	0.4418	0.4429	0.4441
1.6	0.4452	0.4463	0.4474	0.4484	0.4495	0.4505	0.4515	0.4525	0.4535	0.4545
1.7	0.4554	0.4564	0.4573	0.4582	0.4591	0.4599	0.4608	0.4616	0.4625	0.4633
1.8	0.4641	0.4649	0.4656	0.4664	0.4671	0.4678	0.4686	0.4693	0.4699	0.4706
1.9	0.4713	0.4719	0.4726	0.4732	0.4738	0.4744	0.4750	0.4756	0.4761	0.4767
2.0	0.4772	0.4778	0.4783	0.4788	0.4793	0.4798	0.4803	0.4808	0.4812	0.4817
2.1	0.4821	0.4826	0.4830	0.4834	0.4838	0.4842	0.4846	0.4850	0.4854	0.4857
2.2	0.4861	0.4864	0.4868	0.4871	0.4875	0.4878	0.4881	0.4884	0.4887	0.4890
2.3	0.4893	0.4896	0.4898	0.4901	0.4904	0.4906	0.4909	0.4911	0.4913	0.4916
2.4	0.4918	0.4920	0.4922	0.4925	0.4927	0.4929	0.4931	0.4932	0.4934	0.4936
2.5	0.4938	0.4940	0.4941	0.4943	0.4945	0.4946	0.4948	0.4949	0.4951	0.4952
2.6	0.4953	0.4955	0.4956	0.4957	0.4959	0.4960	0.4961	0.4962	0.4963	0.4964
2.7	0.4965	0.4966	0.4967	0.4968	0.4969	0.4970	0.4971	0.4972	0.4973	0.4974
2.8	0.4974	0.4975	0.4976	0.4977	0.4977	0.4978	0.4979	0.4979	0.4980	0.4981
2.9	0.4981	0.4982	0.4982	0.4983	0.4984	0.4984	0.4985	0.4985	0.4986	0.4986
3.0	0.4987	0.4987	0.4987	0.4988	0.4988	0.4989	0.4989	0.4989	0.4990	0.4990
3.1	0.4990	0.4991	0.4991	0.4991	0.4992	0.4992	0.4992	0.4992	0.4993	0.4993
3.2	0.4993	0.4993	0.4994	0.4994	0.4994	0.4994	0.4994	0.4995	0.4995	0.4995
3.3	0.4995	0.4995	0.4995	0.4996	0.4996	0.4996	0.4996	0.4996	0.4996	0.4997
3.4	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4997	0.4998

- oooOooo -